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Ecological evaluation of mud flat habitats on the coast of Maine constructed of dredged material

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In 1988 the U.S. Army Engineer Division, New England, constructed an intertidal mud flat at Sheep Island near Jonesport, Maine, to provide a beneficial use of dredged material. Previous beneficial uses in coastal regions have included construction of salt marshes, bird islands, berms, oyster beds, and seagrass beds. No documentation is known to exist on the use of dredged material to build intertidal mud flats, although this habitat may have resulted incidentally from various dredged material disposal projects.

The Jonesport project was advantageous in that dredging records indicated dredged material had been placed in the intertidal zone at nearby Beals Island during the mid-1960s, affording an opportunity to also examine long-term conditions on a constructed mud flat.

Jonesport, situated approximately 50 miles south of the United States-Canada border (Figure 1), experiences a tidal amplitude as great as 12 feet. Beals, Great Wass, and Head Harbor Islands protect the local coastline from direct exposure to Atlantic Ocean swells and storm waves. Tidal flats have developed in the lee areas of most islands in the vicinity and provide habitat for commercially important species such as softshell clams (*Mya arenaria*) and baitworms (the sandworm *Nereis virens* and the bloodworm *Glycera dibranchiata*) (Figure 2) and foraging habitat for fish, shrimp, crabs, and shorebirds.

Raking for worms

Placement of dredged material at Beals Island pre-dated the National Environmental Protection Act, and no monitoring was conducted. However, anecdotal accounts of the creation of viable softshell clam and baitworm habitat led to the planning of a beneficial use project at Sheep Island. Construction of a mud flat at Sheep Island involved placement of 100,000 cubic yards of silty sands derived from an improvement project at Jonesport Harbor and a maintenance project at a nearby Coast Guard station. Three acres of previously shallow subtidal sand and gravel were covered, to provide habitat suitable for commercially important species.

The objective of the ecological evaluation described in this article was to determine if a constructed mud flat will develop harvestable levels of softshell clams and baitworms as well as a natural infaunal community.

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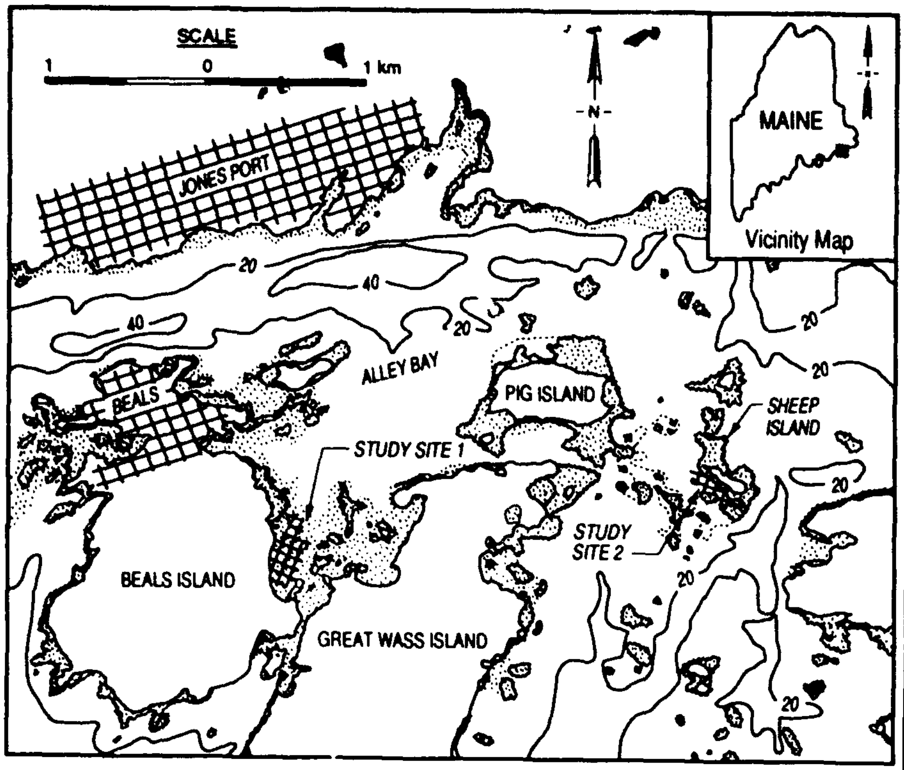

Figure 1. Jonesport, Maine, and vicinity

In 1990 and 1991, numerous 0.02-square meter pits were dug with a shovel, and the sediments were rinsed through a 1-cm mesh screen. All softshell clams and baitworms retained on the screen were counted and measured. In addition, pits were dug using a hand rake identical to that used by commercial diggers for a standard 5-minute period at random locations in the constructed mud flats and reference areas.

In 1992, to remove variation due to raking skill among diggers and increase the areas covered, 1-square meter quadrats were thoroughly raked. Infaunal samples were obtained with a 7.5-cm-diameter coring tube and processed through 0.5-mm sieves. All specimens were identified to the lowest possible taxonomic level and counted.

Mud flats comprise 27 percent of total intertidal habitat in Maine (Maine State Planning Office 1983) and twice the acreage of all fresh- and saltwater marsh habitats combined (Field and others 1991). Softshell clams and baitworms produced on these flats are an important economic resource, and mud flat infauna provide forage for many commercially and ecologically important species of fish, crustaceans, and shorebirds.

The Sheep Island constructed mud flat and a reference site were first monitored in September 1990 for sediment grain size, softshell clams and baitworms, and infaunal community structure. These efforts, repeated in September 1991 and August 1992, were extended to include a constructed mud flat and reference areas at Beals Island. Sediments were analyzed for grain size distribution and organic content. Softshell clams and baitworms were assessed by two methods.

Figure 2. Softshell clam (*Mya arenaria*) (upper) and sandworm (*Nereis virens*) (lower)

Sediment characteristics

Sediments at the Sheep Island constructed mud flat were predominantly silt-clays and fine sands. In contrast, the reference area was dominated by coarse to fine sands with appreciable amounts of gravel. Constructed mud flat sediments also had higher organic content than the reference site.

Grain size analysis of Beals Island sediments was performed only in 1992. The Beals Island constructed mud flat sediments were primarily silt-clays, whereas the reference site sediments were composed of nearly equal amounts of silt-clays and sand. Constructed mud flat sediments had higher organic content than reference site sediments.

Softshell clams and baitworms

The selected "target resources" for the Sheep Island beneficial use project were softshell clams and baitworms. Because of the limited scope of the monitoring involved in this project, densities of these animals were semiquantitatively assessed.

The time- or area-standardized rake samples revealed several consistent patterns. At Sheep Island, numbers of softshell clams were higher on the constructed mud flat, although the samples were dominated by smaller sized softshell clams than at the reference area (Figure 3). Sandworms were more numerous at the reference area in 1991, but densities were greater at the constructed mud flat in 1992. As was seen for softshell clams, sandworms collected on the constructed mud flat were of smaller average size

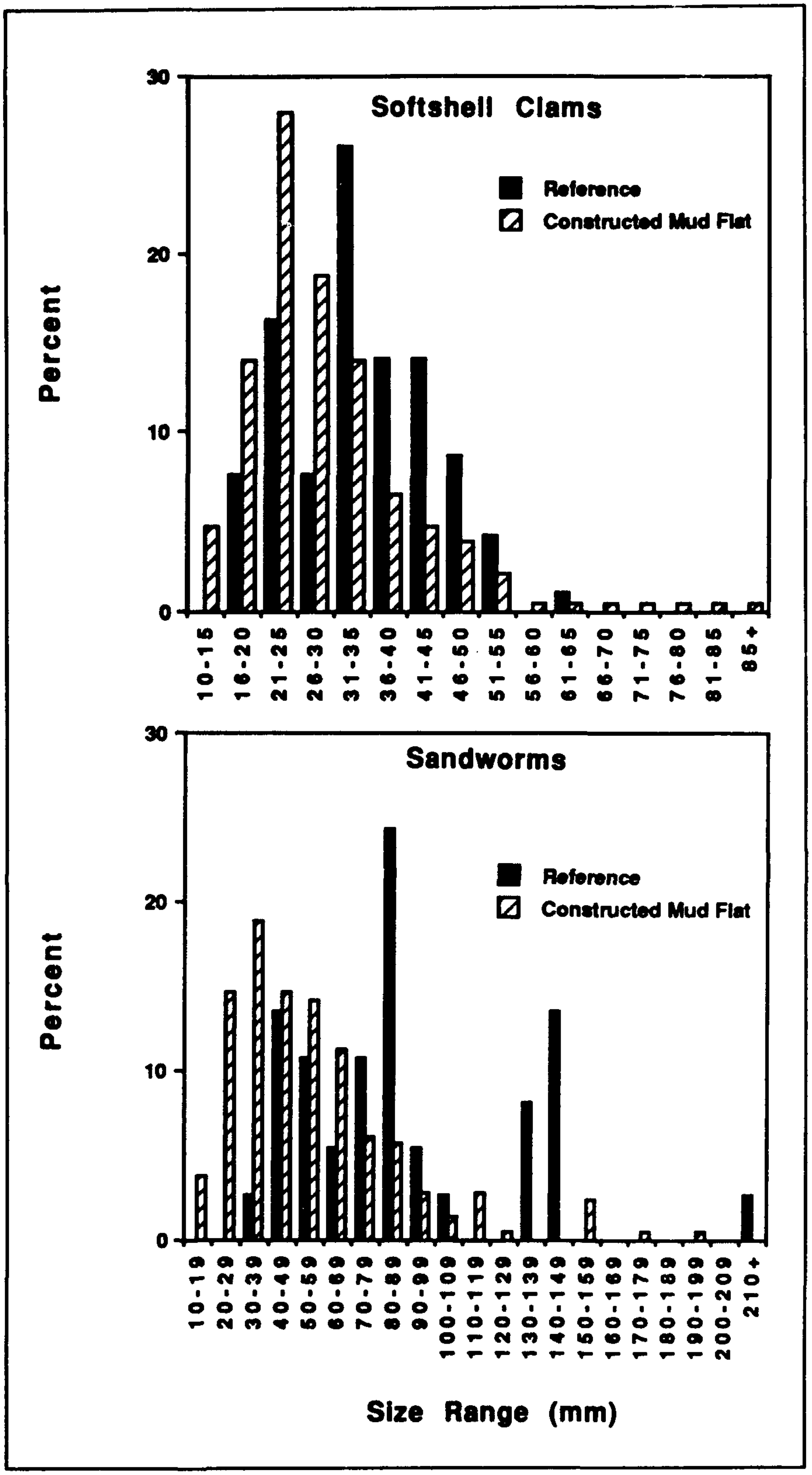

Figure 3. Size comparison of target species at constructed mud flat and reference area, Sheep Island, 1992

than at the reference area. There was no apparent difference, however, in the absolute number of reproductive-size sandworms (>200 millimeters, total length) between sites. Too few bloodworms (*G. dibranchiata*) were collected for making site comparisons at Sheep Island.

No softshell clams were found in Beals Island reference area samples in 1991, and very few were taken in 1992. However, softshell clams that were present tended to be of commercial size (>50 millimeters). Softshell clams in the 1992 constructed mud flat samples were primarily in the 30- to 45-millimeter range. Sandworms were essentially absent from the Beals Island reference site in both 1991 and 1992, whereas substantial populations were collected on the constructed mud flat, particularly in 1992. The population at the constructed mud flat had large numbers of reproductive-size sandworms but was dominated by individuals in the 100- to 130-millimeter size range.

The higher numbers of softshell clams and baitworms on the constructed mud flat compared to the reference areas at Sheep Island probably reflect the preference of softshell clams and baitworms for softer sediments (Newell and Hidu 1986, Wilson and Ruff 1988). This might also account for differences seen at Beals Island, although intensive commercial digging is probably an important factor at the latter site. Diggers were active sporadically during low tide during the study sampling dates, and numerous depressions of recent raking pits were scattered throughout the area. No evidence of raking was noted at Sheep Island, which is accessible only by boat.

Infaunal communities

Infauna were sampled at Sheep Island in 1990, 1991, and 1992. In 1990, taxa richness (species per core) and total abundance (animals per square meter) at the reference area were nearly double those of the constructed mud flat (Figure 4). The difference in taxa richness between sites decreased in 1991 and 1992, and the difference in total abundance became negligible. Species composition also varied over time. The constructed mud flat was initially dominated by the polychaetes *Pygospio elegans*, *Capitella* sp., and *Polydora quadrilobata*, and later by *Exogene hebes* and the amphipod *Corophium volutator*. Oligochaetes were an important component of the mud flat site but never accounted for more than 13 percent of total abundance. In contrast, the reference area was dominated by oligochaetes, the polychaetes *Capitella* sp., *Fabricia sabella*, and *E. hebes*, and the amphipod *C. volutator*.

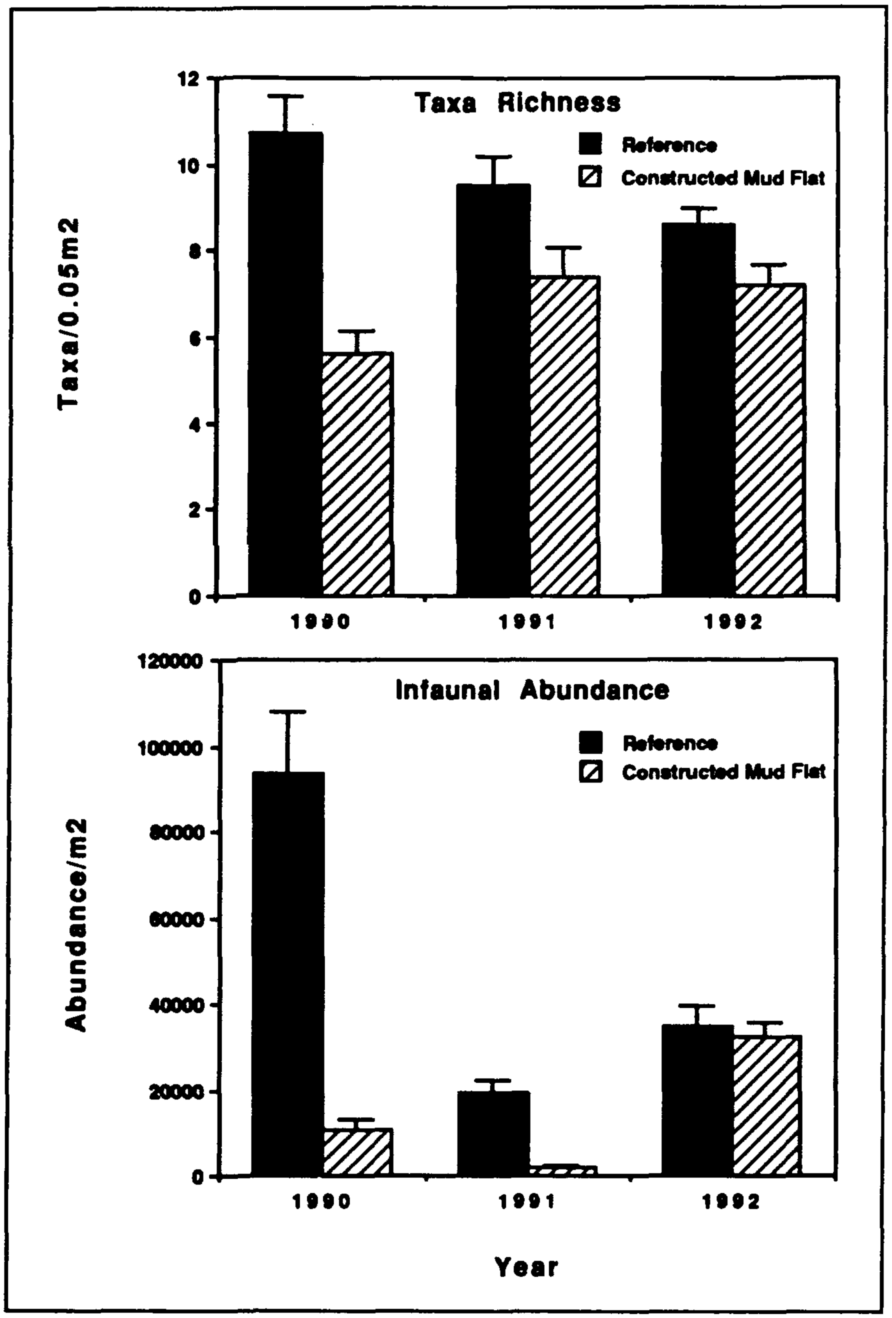

Figure 4. Infaunal taxa richness and abundance, Sheep Island, 1990-1992

Differences between the infaunal assemblages at the constructed mud flat and reference areas at Beals Island were much less distinct than at Sheep Island. Although densities at the Beals Island reference area were twice as high as the constructed mud flat, there was no difference in taxa richness. Community composition was also similar: oligochaetes constituted 30 to 40 percent of all animals at both sites, and the amphipod *Phoxocephalus holbolli* and the polychaetes *Streblospio benedicti* and *Polydora quadrilobata* consistently made up an additional 10 to 20 percent of total abundances. Polychaetes such as *E. hebes*, *Clymenella torquata*, and *Capitella* sp. were prevalent at the reference site, and the polychaete *Polydora ligni* and the amphipod *Ampelisca abdita* were prevalent at the mud flat site.

Differences between infaunal communities at constructed mud flat and reference sites at both Sheep and Beals Islands can largely be explained by differences in sediment characteristics and interannual variability of individual species. Infaunal communities are sensitive to sediment silt-clay content, and both constructed mud flats had substantially higher silt-clays than their respective reference areas. Single sampling events per year also cannot discern interannual dynamics of individual infaunal populations. This may account for the dominance of *E. hebes* and the amphipod *P. holbolli* at both Sheep Island sites in 1991 but not in the preceding or following years. *Phoxocephalus holbolli* was also abundant at Beals Island, principally in 1991.

In general, infaunal communities sampled at Sheep and Beals Islands closely resemble other Maine mud flat assemblages described by Larsen and Doggett (1991). Taxonomic composition, abundance, and taxa richness values at reference and constructed mud flat areas fell within the ranges reported by Larsen and Doggett (1991).

Summary

Placement of dredged material at Sheep Island created an intertidal habitat that closely resembles natural mud flat habitat faunistically. Although rates of colonization of the constructed mud flat cannot be estimated from these data, a diverse infaunal assemblage was present within 2 years, and abundances generally increased through the fourth post-construction year. Softshell clams and sandworms appeared to have recruited in substantial numbers to the constructed mud flat. Sizable populations were evident at the conclusion of the monitoring efforts.

Subtle differences in sediments and fauna were detected between constructed mud flat and reference sites at Beals Island nearly 30 years after disposal of the dredged material.

Mud flat construction exemplified by this project does involve a trade-off in habitat type. Three acres of soft intertidal habitat gained represents an equal amount of coarser subtidal habitat lost. The net benefit of an individual project must be evaluated within a larger context of resource management. This project has demonstrated, however, that mud flat construction offers a dredged material disposal alternative that may compare favorably from an environmental standpoint with other modes of disposal.

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Calendar of Dredging-Related Events

September 7-9, 1994	**Challenges and Opportunities in the Marine Environment—1994 Marine Technology Annual Conference and Exposition**, Washington, DC, POC: Beth Cain, (703) 631-6200; FAX (703) 818-9177
November 13-16, 1994	**Dredging '94 Seminar**, Buena Vista Palace Hotel, Lake Buena Vista, FL, POC: Charles Calhoun, (601) 634-2001
December 12-16, 1994	**Dredged Material Assessment and Management Seminar**, Radisson Suite Hotel, New Orleans, LA, POC: Tom Patin, (601) 634-3444

PIANC establishes Permanent Environmental Commission

PIANC (the Permanent International Association of Navigation Congresses) recently established a Permanent Environmental Commission (PEC) to add a new dimension to this important intergovernmental organization. Administratively, the PEC will serve at the same level as PIANC's two Permanent Technical Committees, and the PEC Chairman will serve on the PIANC Executive Committee.

Dr. Robert M. Engler of WES, who is the U.S. Commissioner to the PEC, was also selected as chairman. PEC was created to focus the environmental activities within PIANC by "supporting the principles of sustainable development and actively promoting a holistic approach to managing environmental issues related to navigation," explains Dr. Engler.

Traditionally PIANC, as an intergovernmental organization, has played a significant role in the exchange of technical information and views on all aspects of the planning, design, management, and maintenance of waterborne transport and the supporting navigation infrastructure. In establishing the PEC, this reputable international organization has now undertaken the task of placing environmental concerns at the highest level and will soon play a global leadership role in shaping future environmental issues as they evolve from other international treaties in which the United States and other PIANC members are involved.

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Intertidal mud flat habitat was constructed in 1988 to provide a beneficial use of dredged material near Jonesport Harbor, Maine. An ecological evaluation was conducted to determine if this constructed habitat would develop harvestable levels of softshell clams and baitworms, as well as a natural infaunal community. Results, described in this issue, demonstrate that mud flat construction offers a dredged material disposal alternative that compares favorably from an environmental standpoint with other modes of disposal.

ENVIRONMENTAL EFFECTS OF DREDGING

This bulletin is published in accordance with AR 25-30 as an information dissemination function of the Environmental Laboratory of the Waterways Experiment Station. The publication is part of the technology transfer mission of the Dredging Operations Technical Support (DOTS) Program managed by the Environmental Effects of Dredging Programs. Results from ongoing research programs will be presented. Special emphasis will be placed on articles relating to application of research results or technology to specific project needs. Contributions of pertinent information are solicited from all sources and will be considered for publication. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or the approval of the use of such commercial products. Communciations are welcomed and should be addressed to the Environmental Laboratory, ATTN: Dr. Robert M. Engler, U.S. Army Engineer Waterways Experiment Station (CEWES-EP-D), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call AC 601/634-3624.

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